

76. A device manufacturing method, comprising the steps of:
exposing a workpiece with a pattern by use of an exposure apparatus as recited in
Claim 69; and
developing the exposed workpiece. --

REMARKS

Applicant requests favorable reconsideration and allowance of the subject application in view of the preceding amendments and the following remarks.

To place the subject application in better form, the specification has been amended to correct minor informalities. Also, a new abstract is presented in accordance with preferred practice. No new matter has been added by these changes.

Claims 45-76 are presented for consideration in lieu of claims 1-44, which have been canceled without prejudice or disclaimer. Claims 45, 53, 61 and 69 are independent. Support for these claims can be found in the original application, as filed. Therefore, no new matter has been added.

Applicant requests favorable reconsideration and withdrawal of the rejection set forth in the above-noted Office Action.

Claims 1-44 were rejected under 35 U.S.C. § 102 as being anticipated by U.S. Patent No. 5,696,623 to Fujie et al. Applicant submits that this patent does not teach many features of the present invention, as previously recited in claims 1-44. Therefore, this rejection is respectfully

traversed. Nevertheless, Applicant submits that claims 45-76, as presented, amplify the distinctions between the present invention and the cited art.

The present invention, as recited in independent claims 45, 53, 61 and 69, relates to various aspects of exposure apparatus for illuminating a pattern with light from a light source and for exposing a predetermined surface with light from the pattern. The apparatus includes a projection optical system for projecting the pattern onto the predetermined surface, the projection optical system having at least one optical element having optical surfaces. The apparatus also includes gas supply means for locally supplying a gas to the at least one optical element.

As recited in independent claim 45, the gas supplying means directly blows the gas toward one of the optical surfaces of the at least one optical element, which is closest to the predetermined surface, from the predetermined surface side.

As recited in independent claim 53, the gas supplying means directly blows the gas toward one of the optical surfaces of the at least one optical element, which is closest to the pattern, from the pattern side.

As recited in independent claim 61, the gas supplying means produces a laminar gas flow between the predetermined surface and one of the optical surfaces of the at least one optical element, which is closest to the predetermined surface.

As recited in independent claim 69, the gas supplying means produces a laminar gas flow between the pattern and one of the optical surfaces of the at least one optical element, which is closest to the pattern.

Applicant submits that the cited art does not teach or suggest such features of the present invention, as recited in the independent claims.

The Fujie et al. patent shows an exposure apparatus that includes a gas supplying arrangement. In that patent, however, the gas supplying arrangement supplies a gas between optical elements of the projection optical system. Therefore, that patent is completely silent as to supplying a gas between an optical element of a projection optical system and a predetermined surface to be exposed or between an optical element of the projection optical system and a pattern to be transferred by the projection optical system, in the manner of the present invention recited in the independent claims.

Still further, Figures 2A-2D and 3A-3D of the Fujie et al. patent show that the gas supplying arrangement would inevitably produce a turbulent flow. This is in direct contrast to the present invention recited in independent claims 61 and 69, which provides for a laminar flow.

For the reasons noted above, Applicant submits that the Fujie et al. patent does not teach or suggest the salient features of Applicant's present invention, as recited in the independent claims. Accordingly, Applicant submits that the present invention, as recited in independent claims 45, 53, 61 and 69, is patentably defined over the cited art.

Dependent claims 46-52, 54-60, 62-68 and 70-76 also should be deemed allowable, in their own right, for defining other patentable features of the present invention in addition to those recited in their respective independent claims. Further individual consideration of these dependent claims is requested.

Applicant further submits that the instant application is in condition for allowance.
Favorable reconsideration, withdrawal of the rejection set forth in the above-noted Office Action
and an early Notice of Allowance are requested.

Applicant's undersigned attorney may be reached in our Washington, D.C. office by
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Respectfully submitted,



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APPENDIX A

IN THE ABSTRACT

[Disclosed are an optical structure and an exposure apparatus having the same, in which a clean gas is supplied efficiently to the surface, or in the neighbourhood thereof, of an optical element being isolated from a surrounding ambience, thereby to keep the surface clean and to prevent adhesion depositions thereon. This assures minimization of the influence of the gas flow to the imaging performance, such that contamination of the optical element can be prevented with a very small amount of gas flow. To this end, an inactive gas is blown directly against the surface of the optical element or, alternatively, it is flown along the surface in the form of a laminar flow.]

-- An exposure apparatus for illuminating a pattern with light from a light source and for exposing a predetermined surface with light from the pattern includes (i) a projection optical system for projecting the pattern onto the predetermined surface, the projection optical system having at least one optical element having optical surfaces, and (ii) a gas supplying device for locally supplying a gas to the at least one optical element. In one aspect, the gas supplying device directly blows the gas toward one of the optical surfaces of the at least one optical element, which is closest to the predetermined surface, from the predetermined surface side. --

IN THE SPECIFICATION:

Please substitute the paragraph beginning at page 1, line 15, with the following.

-- Semiconductor integrated circuits [are] have become more and more miniaturized year after year, and, in order to meet this, exposure apparatuses for transferring a circuit pattern onto a wafer are required to have a performance capable of transferring a finer pattern. Thus, the wavelength of exposure light used in such exposure apparatuses becomes shorter and shorter. Currently, i-line (wavelength 365 nm) or KrF excimer laser light (wavelength 245 nm) are used widely. Further, use of ArF excimer laser light (wavelength 193 nm) has been started, and use of F₂ laser light has been attempted. --

Please substitute the paragraph beginning at page 3, line 14, and ending on page 4, line 3, with the following.

-- However, it is practically difficult to purge the entire path of exposure light. Particularly, in the [neighbourhood] neighborhood of a reticle or a wafer, there is a stage which is movable. Therefore, it is difficult to separate only the light path from the surrounding ambience and to purge the same. Further, there are cases wherein the light path between adjacent units extends through a surrounding ambience. In addition, while there are optical elements provided at a light entrance port and a light exit port of each container, containing a unit of optical elements, the surfaces of these optical elements facing the surrounding ambience are exposed

directly to the ambience and, therefore, depositions may be adhered to them. This leads to degradation of the optical performance, such as a decrease of illuminance, for example, and thus it causes a necessity of periodic washing or replacement. --

Please substitute the paragraph beginning at page 4, line 4, with the following.

-- Particularly, one of optical elements of a projection optical system which is closest to a wafer is directly exposed to a gas produced from a resist. As a result, the transmission factor of it decreases most. In order to avoid this, a gas may be [flown] caused to flow in one direction, along a space between a wafer and a lens, such as shown in Figure 2. Here, in exposure apparatuses, any fluctuation in an ambience is adversely influential to the imaging performance. Further, in scan type exposure apparatuses, since a stage moves, a gas from a resist is easily mixed. It is, therefore, very difficult to decrease the impurity concentration at the lens surface effectively. --

Please substitute the paragraph beginning at page 4, line 17, and ending on page 5, line 16, with the following.

-- In these methods, a gas product from a wafer is rather conveyed to the lens surface, along the gas flow, such that sufficient contamination prevention is not attainable. Japanese Laid-Open Patent Application, Laid-Open No. 26038/1994 shows a method in which an inactive gas is supplied through a supply port provided on a stage, in parallel to a wafer and, simultaneously, a gas is supplied toward the wafer from the bottom end of a projection optical

system, in parallel to the optical axis. This method has paid a particular note to an oxygen concentration in the space from the projection optical system to the wafer, but the efficiency itself regarding the contamination prevention at the bottom face of the projection optical system is not so good. Between a projection lens and the surface of a wafer, measurement light for measuring the imaging position passes. Any change in temperature or pressure of an ambience in the space through which the measurement light passes, leads to a measurement error, and this applies a large influence to the position adjustment for the wafer imaging position. Further, a change in temperature or pressure of the ambience is also influential to the imaging performance. For these reasons, the flow of a gas of a large flow rate or any fluctuation in pressure or temperature causes an error of the wafer position adjustment and degradation of the imaging performance. --

Please substitute the paragraph beginning at page 5, line 19, and ending on page 6, line 4, with the following.

-- It is accordingly an object of the present invention to provide an optical structure and/or a method of preventing contamination of the same, in which a clean gas is supplied efficiently to the surface, or in the [neighbourhood] neighborhood thereof, of an optical element being isolated from a surrounding ambience, thereby to keep the surface clean and to prevent adhesion of depositions thereon. This assures minimization of the influence of the gas flow to the imaging performance and adjustment of the imaging position, for example, such that contamination of the optical element can be prevented with a very small amount of gas flow. --

Please substitute the paragraph beginning at page 9, line 19, with the following.

-- In accordance with another aspect of the present invention, there is provided an exposure apparatus for illuminating a pattern with light from a light source and for projecting light from the pattern onto a surface to be exposed, said apparatus comprising: an optical structure as recited above, wherein the light from the light source is light of an ultraviolet region. --

Please substitute the paragraph beginning at page 10, line 12, with the following.

-- In accordance with a yet further aspect of the present invention, there is provided an optical structure, comprising: an optical element; and a gas supplying means for supplying a gas to a surface of the optical element, wherein the gas supplied to the surface of the optical element defines a laminar flow at and adjacent to the surface of the optical element. --

Please substitute the paragraph beginning at page 11, line 18, with the following.

-- The optical structure may further comprise [a] gas supplying equipment having impurity removing means, for supplying a gas to said gas supplying means. --

Please substitute the paragraph beginning at page 12, line 25, and ending on page 13, line 9, with the following.

-- The optical structure may further [comprising] comprise (i) a plurality of optical elements, (ii) a plurality of gas supplying means disposed along a direction substantially perpendicular to a direction in which the gas is to be supplied, (iii) a container isolated from a surrounding ambience, wherein said plurality of optical elements may be disposed at least at a light entrance surface and a light exit surface of said container, and (iv) a cover for covering the light entrance surface and/or the light exit surface of said container, wherein said plurality of gas supplying means may be provided inside said cover. --

Please substitute the paragraph beginning at page 15, line 20, and ending on page 16, line 6, with the following.

-- In the preferred embodiments of the present invention to be described below, the arrangements described above are applied by which a gas which may contain only a very small quantity of impurities, causing depositions, can be blown against a limited portion of the surface of an optical element, facing [to] a surrounding ambience, or can be [flown] caused to flow to produce a laminar flow. Thus, an ambience with a very small quantity of impurities can be produced adjacent to the surface of the optical element, and adhesion of deposition thereto can be suppressed. As a result, contamination of the surface of the optical element, facing [to] the surrounding ambience, can be prevented efficiently. --

Please substitute the paragraph beginning at page 16, line 13, with the following.

-- A gas supply port may be provided at one side of the lens surface while a gas discharging port may be disposed at the opposite side of the lens surface, so that a gas [is flown] flows along the lens surface. This enables that a clean ambience is locally produced at the lens surface only by use of a small flow rate of the gas. --

Please substitute the paragraph beginning at page 17, line 20, with the following.

-- However, one face of the [top most] top-most lens and one face of the bottom lens are exposed to be the ambience of the exposure apparatus chamber. In consideration of it, a plurality of gas supply ports 13 are provided around the [bottommost] bottom-most lens of the projection system, about the lens optical axis, to surround the lens. --

Please substitute the paragraph beginning at page 17, line 27, and ending on page 18, line 9, with the following.

-- Gases 15 discharged from these gas supply ports flow along the lens surface toward the center of the lens. Adjacent to the center, the gases flow as a downward stream, and they are diffused. In order to produce an effective flow, the flow rate and the flow speed, for example, should be controlled. To this end, an optimum shape of the discharging port 15 as well as an optimum flow rate and pressure of the gas are determined in accordance with the shape and size of the lens, for example. --

Please substitute the paragraph beginning at page 18, line 22, with the following.

-- Exposure apparatuses may be individually equipped with impurity removing devices such as filters. However, a gas supplied from a factory or [an] experimental equipment, having an impurity removing function, may be used. --

Please substitute the paragraph beginning at page 18, line 27, and ending on page 19, line 10, with the following.

-- The type of gas to be used may be chosen in accordance with the wavelength of ultraviolet rays, for example, to be used in the exposure apparatus. An atmosphere may be used where i-line or a KrF laser is used. [Where] When light of a shorter wavelength is used, an inactive gas such as nitrogen or He, for example, may be used. [Where] When an inactive gas is supplied directly from a commercially available high purity cylinder, for example, since substantially no impurity is contained therein, the impurity removing device may be omitted. --

Please substitute the paragraph beginning at page 19, line 20, and ending on page 20, line 10, with the following.

-- A valve 14 for adjusting the flow rate of the supplied gas may be controlled so as to adjust the gas flow rate in accordance with the state of exposure operation. This enables a more effective supply of a clean gas to the lens surface. For example, during an alignment process, during an imaging position measuring process or during an exposure process, the flow of a gas applies a large influence to the imaging performance. Therefore, the gas flow rate should be restricted. On the other hand, during a wafer conveying process, for example, the gas flow can

be increased. Thus, when a new wafer is conveyed onto a wafer stage, the supplying flow rate may be increased, thereby to effectively remove an impurity gas, produced from a resist, away from the lens. During the alignment and exposure process, the flow rate may be decreased to prevent adverse influence to the imaging performance. --

Please substitute the paragraph beginning at page 20, line 11, with the following.

-- [Where] When a gas of the same type as that of the gas used inside the barrel can be used and [flown] caused to flow along the lens surface, as shown in Figure 3, the gas may be supplied from a gas discharging port of the projection barrel. --

Please substitute the paragraph beginning at page 20, line 18, with the following.

-- Figure 4 is a schematic view of a second embodiment of the present invention. In the gas supplying method of the first embodiment, there may be cases wherein, depending on the size or shape of the lens, for example, the gas [flown] that flows from the lens to the wafer surface is diffused of a resist gas. In consideration of it, as shown in Figure 4, a gas discharging port 17 may be provided below the supply port. This is effective to produce a gas flow. --

Please substitute the paragraph beginning at page 21, line 1, with the following.

-- Also, in this case, there may be a plurality of gas discharging ports disposed revolutionally symmetrically with respect to the optical axis, like the gas supply ports. --

Please substitute the paragraph beginning at page 21, line 27, and ending on page 22, line 14, with the following.

-- A gas supply port 18 and a gas discharging port 20 are provided in the [neighbourhood] neighborhood of the [bottommost] bottom-most lens of the projection system, that is, the lens 3 closest to the wafer, and the lens surface of the barrel 22 at the top of the projection system, facing [to] the chamber ambience side, such that a clean gas is [flown] caused to flow. As shown in Figure 5B, the gas supply port 18 is provided at one of lens side faces while the gas discharging port 20 is provided at the opposite lens side face, by which an effective gas flow is produced locally upon the lens surface. Particularly, plural gas supply ports and plural gas discharging ports may preferably be provided. [In] On that occasion, a gas flows uniformly along the lens surface. --

Please substitute the paragraph beginning at page 22, line 23, and ending on page 23, line 9, with the following.

-- A flow rate adjusting valve 19 may be used to adjust the flow rate and flow speed of the gas so that a laminar flow is produced. In this method, although the gas flow is only in one direction, the ambience at the lens surface can be effectively kept clean with use of only a limited flow rate of the gas. Therefore, the influence to the imaging performance or imaging position measurement is small. Further, there is an advantage that only a relatively narrow space is required. Moreover, since a gas [is flown] flows only locally on the lens surface, in the case of a

scan type exposure apparatus, the influence of resist gas diffusion due to the motion of the stage, for example, can be made small. --

Please substitute the paragraph beginning at page 23, line 10, with the following.

-- Between a projection optical system and a wafer, a probe light for focus position measurement passes. If there occurs non-uniformness of pressure or temperature in the ambience through which the probe light passes, it causes a measurement error. In consideration of this, usually, a gas of the same type as that of the chamber ambience is used. In this embodiment, however, since the gas flow is stable, a gas having a refractive index different from that of the ambience gas may be used. For example, in a case [where] wherein the chamber ambience is atmosphere, a nitrogen gas may be [flown] caused to flow. [Where] When the barrel inside space is purged by the same type of gas, the same gas line may be used. If a different type of gas is to [be flown] flow, a separate line is necessary. [Where] When the same gas line as that of the chamber ambience is used, since the gas must be sufficiently clean, gas purifying means such as a filter may be used, as required. --

Please substitute the paragraph beginning at page 24, line 1, with the following.

-- This embodiment is applicable not only to a projection system but also to a portion of a separate optical system such as an illumination system, for example, as shown in Figure 6. Figure 6 is a schematic and sectional view of an optical system, wherein an optical system 23 is accommodated inside a barrel 22 being isolated from a surrounding ambience. Along the optical

path, the ambience is isolated by means of a seal glass 24 which comprises a parallel flat plate. The inside of the barrel is purged by a clean gas, through a gas supply port 25 and a gas discharging port 26. In order that a clean gas flows along the surface of the seal glass 24, being in contact with the surrounding ambience, a gas supplying port 27 is provided at one side face while a gas discharging port 28 is provided at the opposite side face. By adjusting the flow rate and the pressure, a gas is [flown] caused to flow along the seal glass surface. --

Please substitute the paragraph beginning at page 24, line 25, and ending on page 25, line 8, with the following.

-- In accordance with the embodiments of the present invention described hereinbefore, a clean gas is efficiently supplied to the surface, or adjacent thereto, of the surface of an optical element isolated from a surrounding ambience, which surface faces [to] the surrounding ambience. This assures that the surface of the optical element is kept clean, and adhesion of the depositions can be prevented effectively. Thus, contamination prevention, which is particularly suitably applicable to a semiconductor exposure apparatus, is accomplished. --